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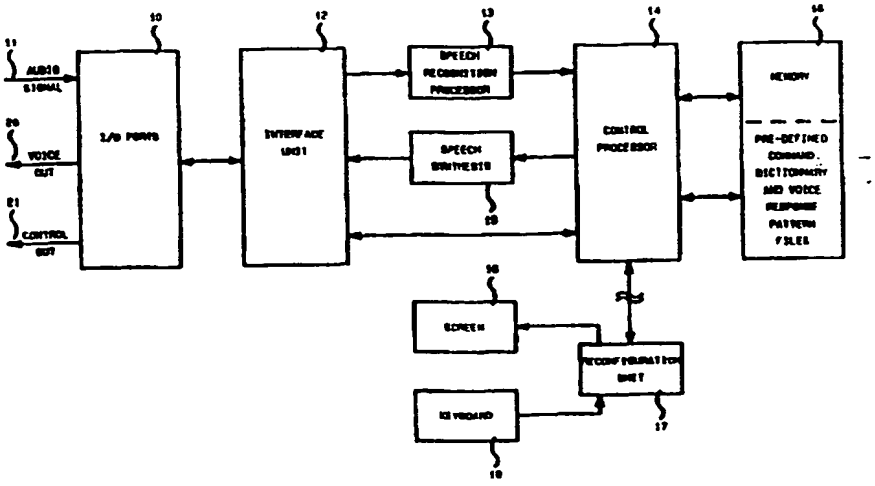
(54) Title: SYSTEM FOR ACTIVATION AND CONTROL OF REMOTE NAVIGATIONAL GUIDANCE EQUIPMENT BY RADIO TRANSMITTED VOICE COMMANDS



(57) Abstract

A system for the remote activation and operation of access control or reading of navigational guidance equipment located at a distant facility such as an aerodrome or harbour by means of radio. The invention allows the operator of a vessel or vehicle approaching the facility to initiate the activation of, and to control, access control or interrogate navigational guidance equipment such as lighting through operator-initiated, facility-specific, radio transmitted voice commands which are recognized and translated into an electronic control signal by a speech recognition device. The signal in turn actuates the equipment which the command has designated. The invention also provides means for synthesizing verbal responses to the operator to provide feedback concerning the status of the operator's command. The invention also includes interfacing means for presenting both an electronic control signal to the selected facility equipment and verbal response or acknowledgement to the operator.

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SYSTEM FOR ACTIVATION AND CONTROL OF REMOTE NAVIGATIONAL GUIDANCE EQUIPMENT BY RADIO TRANSMITTED VOICE COMMANDS

BACKGROUND OF THE INVENTION

The present invention relates to a system for actuating and controlling operative functions of remote navigational guidance equipment using voice commands transmitted by radio.

In particular, the present invention seeks to mitigate and obviate disadvantages inherent in the operation of radio equipped vehicles and vessels which require guidance or direction from equipment at remote facilities such as aerodromes, lighthouses, port authorities, etc. The invention provides a system for the activation and operation of remote navigational guidance equipment which comprises means for recognizing and automatically executing radio transmitted voice commands, without the need to retrofit the vehicles or vessels with new equipment.

The invention allows the operator of a vessel or vehicle approaching the facility to initiate the activation of, and to control, access control or interrogate navigational guidance equipment such as lighting through operator-initiated, facility- specific, radio transmitted voice commands which are recognized and translated into an electronic control signal by a speech recognition device. The signal in turn actuates the equipment which the command has designated. The invention also provides means for synthesizing verbal responses to the operator to provide feedback concerning the status of the operator's command. The invention also includes interfacing means for presenting both an electronic control signal to the selected facility equipment and verbal response or acknowledgement to the operator.

In a preferred embodiment, the invention has particular application to equipment used in an aerodrome environment such as air traffic control equipment and/or aerodrome facility equipment.

Air traffic control equipment includes but is not limited to instrument landing systems (ILS), Area Surveillance Radar (ASR), Non-Directional Beacons (NDB) and other radio broadcast devices, runway lighting and aerodrome monitoring devices (ceilometer, transmisometer, etc.). In the present state of the art, some of this equipment operates continuously in an unattended mode, while other equipment requires an Air Traffic Controller (ATC) or aircraft pilot to physically direct its operation. For instance, if a pilot is approaching a runway and requires the runway lighting to be illuminated, he requests the ATC to turn them on, at which time the ATC satisfies the request by engaging a control switch on a central command console, which in turn causes the lighting equipment to be illuminated. In the absence of the ATC, the pilot may remotely control the operation of the runway lighting. Using a push to talk (PTT) microphone, the pilot can command the lighting system by repeatedly pressing the talk button in a predefined sequence. The pulse sequence is transmitted from the aircraft by way of a radio broadcast to a radio receiver at the aerodrome, which is linked to a command interpreter which in turn is connected to a variety of runway equipment including the lighting system. Depending on the number of times the talk button is engaged, the runway lighting will be directed to perform a variety of functions (eg. turning the strobe lights on, changing the intensity of the lights, etc.). This system is commercially known as Aircraft Radio Control of Aerodrome Lighting (ARCAL).

Most secondary aerodromes used by private and small commercial aircraft are unmanned, especially at night, and the trend is to move to more unmanned airports, as government resources

become increasingly limited. This will increase the need for aerodrome equipment which can be operated in the absence of an ATC. The present system of engaging aerodrome equipment in the absence of an ATC has numerous disadvantages.

Firstly, the present ARCAL system has a series of drawbacks. Due to the indiscriminate nature of radio broadcast signals, the pulse sequence transmitted by the pilot may cause distant runway lighting systems installed within the radio reception range and which were not intended to be operated by the pilot to be engaged, resulting in unnecessary and considerable consumption of electricity. Furthermore, due to the possibility of a pilot unintentionally changing the runway light settings at other aerodromes, potentially dangerous interference problems may be created between pilots landing simultaneously at different aerodromes within the same range of radio reception. For example, in order to achieve optimal visibility during landing in fog conditions, a pilot may want minimum runway light settings with strobe lights off, while another pilot who is in the process of landing at a nearby aerodrome without fog conditions, may set the runway lighting to maximum intensity with strobe on, and in doing so, may inadvertently activate the same lighting conditions at the aerodrome at which the first pilot intends to land under minimum runway light settings with strobe on.

A further disadvantage is that the ARCAL system has only three lighting control options available to the pilot depending on whether three, five or seven pulses are transmitted. A pilot who remotely activates runway lights by means of ARCAL obtains no feedback signal, other than the visual indication, of whether the lights are indeed turned on and when they will turn off.

A further drawback is that the lighting system may be accidentally engaged in the normal course of pilot-to-pilot

conversation, as microphone talk buttons are engaged to initiate a voice transmission and to acknowledge receipt of a voice transmission.

Another disadvantage of the present system of engaging aerodrome equipment, is that the pilot is unable to receive a variety of required information when the airport is unmanned. Such information includes but is not limited to weather reports, special notices to pilots and the local barometric pressure reading (necessary for proper altimeter setting). A further disadvantage is that the pilot is unable to dial from the air flight service stations on order to close flight plans or contact local emergency services, because present aerodrome phone patch facilities require ATC assistance.

OBJECTS AND SUMMARY OF THE INVENTION

An object of this invention is to provide a system and method which enables an operator of a vehicle or vessel such as a pilot, driver, navigator, ship's master, or the like to remotely activate and control distant access control and navigational guidance equipment by means of voiced commands transmitted by radio. The invention provides means for recognizing radio transmitted voice commands in the form of location identification followed by commands and means for translating said voice commands into an electronic control signal which causes the activation of said access control or the reading of navigational guidance equipment. Preferably, the system also comprises means for generating synthesized speech responses to said voice commands, thereby providing feedback to said operator concerning the operational status of the access control and navigational control equipment.

Another object of this invention is to provide a system capable of discriminating the speech patterns of a plurality of different operators (male, female, soft-spoken, etc.), each of

which will be piloting a vehicle or vessel and forwarding commands to the apparatus from a noise-filled environment and transmitting through a potentially noisy and/or distorting channel.

In one aspect, the invention provides a system for enabling the remote operation and control of remote navigational guidance equipment, comprising: means for recognizing and translating a radio transmitted voice command into an electronic control signal and interfacing means for converting and transferring the control signal to the navigational guidance equipment in a format which operatively engages a function of the navigational guidance equipment which has been designated by the voice command. Preferably, such a system will further comprise means for synthesizing and radio transmitting a human perceptible feedback signal which confirms the operative engagement of the selected function of the navigational equipment.

In a further aspect, the invention provides a system which enables the operator of a vehicle or vessel to remotely activate, control and deactivate a plurality of remote navigational guidance equipment using operator initiated, voice commands transmitted by radio wherein said voice commands are recognized and converted into: electronic control signals which operatively engage specific functions of said navigational guidance equipment correlated with the voice command, and further comprising audible, synthesized speech feedback confirmatory of the operative engagement of the selected function of the navigational guidance equipment.

In a further aspect, the invention provides a system for the remote voice activation and control of navigational guidance equipment by radio transmission, comprising:

a receiver for receiving a remote, radio-transmitted voice command;

speech recognition means for recognizing the voice command with reference to a library of commands and associated control sequences stored in a programmable memory;

control processor means for accessing the library, comparing the voice command with the commands stored in the library and selecting a control sequence which is responsive to the voice command, wherein the control sequence corresponds to a selected operative function of the navigational guidance equipment;

interface means for converting the control sequence into an electronic output signal which is operatively recognizable by the navigational guidance equipment wherein the output signal actuates the selected operative function; and

means for transmitting the electronic output signal to the navigational guidance equipment.

Such a system preferably further comprises speech synthesizing means for generating a coded response command from the control sequence which is confirmatory of the actuation of the selected operative function, means for translating the coded response command into an audible speech signal which is confirmatory of said voice command and of the selection and actuation of the operative function, and means for transmitting the audible speech signal to the originator of the voice command.

Still another aspect of the present invention is to provide a device capable of; (a) creating and storing a library of standardized verbal commands and specific electronic control

signals corresponding to the verbal commands; (b) searching said library of verbal commands upon receipt of a operator request and comparing said request with the library of verbal commands; (c) accessing and sending the corresponding electronic control signal to a distant access control or navigational guidance device such as runway lighting; and (d) generating specific verbal feedback or acknowledgement by way of response to the operator's request.

In a preferred embodiment, the device of the present invention is directed to the remote operation and control of aerodrome equipment, comprising: means for recognizing and translating a pilot's voiced request into an electronic control signal; means for generating speech signals which are delivered to the pilot; interfacing means for presenting the electronic control to the aerodrome equipment in a device recognizable format; and interfacing means for the receipt and transmission of speech to/from the pilot.

In another aspect, the invention provides a method for activating, controlling and deactivating a variety of operative functions in remote navigational guidance equipment, such aircraft control equipment or aerodrome facility equipment, using aerodrome specific, pilot initiated, voice commands transmitted by radio and translated into: (a) electronic control signals which can be recognized by and acted upon by the selected aerodrome equipment; and (b) synthesized speech which provides feedback to the pilot.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a block diagram illustrating the invention.

FIG.2 is a diagrammatic representation of an embodiment of the invention, as it would be configured in the operational setting of an aerodrome.

FIG. 3 is a flow chart illustrating a program control sequence for use of the invention in the operational setting of an aerodrome.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG.1, the operator of a vehicle or vessel such as aircraft 1, transmits a voice command via radio to a facility such as an aerodrome or a lighthouse, which is inputted through a radio receiver (shown representatively in FIG.2 as radio receiver 5). The command passes to I/O ports 10 as voice detection signal 11. Interface unit 12 converts the audio signal 11 into a computer usable format and in turn delivers it to speech recognition unit 13. Speech recognition unit 13, upon receipt of audio signal 11, prepares for the receipt and processing of an operator initiated voice command.

In conjunction with control processor 14 and memory 16, speech recognition unit 13 looks for pre-defined patterns in the operator's request (eg. <facility name> <command>), compares the result with a stored command library and associated control sequences stored in memory 16. Having regard to the voice command, the appropriate control sequence is selected and generated as an electronic signal which is directed to interface 12, and coded for external transmission through I/O ports 10 as control out signal 21. Control signal 21 is then transmitted to activate, control or deactivate an operative function of navigational guidance equipment, such as air traffic control or aerodrome facility equipment, such as interfaces 2, 3, and 4.

Simultaneously, speech synthesis unit 15, in conjunction with control processor 14 and memory 16, determines an appropriate voice response to the operator request and forwards this response through interface unit 12 and I/O port 10 as voice out signal 20.

Reconfiguration unit 17, in conjunction with screen 18 and keyboard 19, is used, either locally or remotely through dialled up-connection to enter, delete and modify data stored within memory 16 including but not limited to the library of stored commands and/or associated control sequences, the recognition and voice response pattern files and/or algorithm, and the facility device control parameters, all of which are acted on by control processor 14.

The control processor 14 is comprised of a conventional data processor operating under the control of an algorithm or program instructions stored in a programmable read only memory.

Speech recognition unit may be a voice recognition chip or module, and associated components, which are commercially available (such as Speech System, IBM, Reptron, etc) and which have been suitably programmed, consistent with the objectives and operation of the invention. The speech recognition unit preferably includes a processor and means for creating a library of specific verbal commands and corresponding electronic control signals; means for storing the library of verbal commands and control signals; means for comparing pilot generated requests to stored verbal commands and corresponding control signals; means for generating or synthesizing speech to indicate control status of the aerodrome device and provide negative/positive feedback to the pilot; and means for delivering the control signal to the navigational guidance equipment and synthesized speech to the pilot.

It will be understood by those skilled in the art that any number of desired functions of a plurality of navigational guidance equipment or related equipment may be activated, controlled and deactivated through suitable programming of control processor 14.

An embodiment of the invention as it would be used within an aerodrome environment is depicted in FIG.2. Aircraft 1 is flown by a pilot approaching the aerodrome facility. Using a radio device standard to all aircraft and transmitting at the designated frequency for the aerodrome, the pilot initiates an aerodrome specific, system defined, radio transmitted verbal request to control the operation of a selected aerodrome device (shown as information services interface 2, runway lighting interface 3, and public phone system interface 4). It will be appreciated that other types of interfaces may be included or substituted, and are within the scope of the invention.

An example of such a request could include "**Kingston tower, lights on.**" The spoken mechanical sound energy produced by the pilot request is converted into electrical signals which are transmitted to antenna 8, attached to radio receiver/transmitter 5. The electrical audio signals are relayed to the Voice Operated Controller of Aerodrome Lighting (VOCAL) device 6. VOCAL 6 recognizes and translates the pilot request (those portions above which are bolded) into an electronic control signal which is returned to VOCAL 6 and finally to an aerodrome device (2, 3 or 4) which acts on the signal (eg. in the example given, lighting interface 3 would turn on runway lights 7). Simultaneously, VOCAL device 6 will synthesize a voice response to the pilot according to the request received. This response will indicate the control status of the aerodrome device and provide negative/positive feedback to the pilot as required. The synthesized speech will be routed to the VOCAL device 6, and in turn to the radio receiver/transmitter 5 where it will be broadcast to the pilot

using antenna 8. With respect to the runway lighting, in the event of a system failure or an unrecognizable command from a pilot, the apparatus will default to the ARCAL system after a pre-programmed number of requests from the pilot.

The sequence of operation is more particularly depicted in the flow chart of Figure 3. The pilot issues a spoken command 25 which identifies the navigational guidance equipment or function to be actuated, together with a specific indication of the location of that equipment (i.e. "Kingston Tower, lights on"). If both aspects of the command (name or geographic designation of specific airport and the navigational guidance function) are recognized by the voice recognition unit (step 26), then a signal which operatively engages the runway lighting system at Kingston airport is generated (step 27). Once the runway lighting is turned on, the further step 28 of generating an audible acknowledgement by way of feedback is carried out.

If both aspects of the spoken, radio-transmitted command are not understood at step 26, a loop 29 is engaged whereby the pilot can repeat the command up to a preprogrammed number of times ("n"), in response to system generated feedback which communicates that the initial spoken command has not been understood (step 30). Once the voiced command has been repeated "n" times without successful recognition by voice recognition unit 14 (step 31), the system defaults to the ARCAL system (step 32) whereby the pilot activates the runway lighting by using the conventional push to talk (PTT) transmission.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A system for enabling the remote operation and control of remote navigational guidance equipment, comprising: means for recognizing and translating a radio transmitted voice command into an electronic control signal and interfacing means for converting and transferring said control signal to said navigational guidance equipment in a format which operatively engages a function of said navigational guidance equipment which has been designated by said voice command.

2. A system as claimed in claim 1 further comprising means for synthesizing and radio transmitting a human perceptible feedback signal which confirms the operative engagement of said function of said navigational equipment.

3. A system as claimed in claim 2 wherein said human perceptible feedback signal is synthesized speech.

4. A system which enables the operator of a vehicle or vessel to activate, control and deactivate a plurality of remote navigational guidance equipment using operator initiated, voice commands transmitted by radio wherein said voice commands are recognized and converted into: electronic control signals which operatively engage specific functions of said navigational guidance equipment correlated with said voice command, and further comprising audible, synthesized speech feedback confirmatory of the operative engagement of said function of said navigational guidance equipment.

5. A system as claimed in claims 1, 2, 3 or 4 wherein said navigational guidance equipment is air traffic control equipment.

6. A system as claimed in claims 1, 2, 3 or 4 wherein said navigational guidance equipment is aerodrome facility equipment.

7. A system for the remote voice activation and control of navigational guidance equipment by radio transmission, comprising:

a receiver for receiving a remote, radio-transmitted voice command;

speech recognition means for recognizing said voice command with reference to a library of commands and associated control sequences stored in a programmable memory;

control processor means for accessing said library, comparing said voice command with the commands stored in said library and selecting a control sequence which is responsive to said voice command, wherein said control sequence corresponds to a selected operative function of said navigational guidance equipment;

interface means for converting said control sequence into an electronic output signal which is operatively recognizable by said navigational guidance equipment wherein said output signal actuates said selected operative function; and
means for transmitting said electronic output signal to said navigational guidance equipment.

8. A system as claimed in claim 7 further comprising speech synthesizing means for generating a coded response command from said control sequence which is confirmatory of the actuation of said selected operative function, means for translating said coded response command into an audible speech signal which is confirmatory of said voice command and of the selection and

actuation of said operative function, and means for transmitting the audible speech signal to the originator of said voice command.

9. A system for the remote voice activation and control of navigational guidance equipment by radio transmission, comprising:

a receiver for receiving a remote, radio-transmitted voice command which designates an operative function of said navigational guidance equipment;

speech recognition means for recognizing said voice command with reference to a library of commands and associated control sequences stored in a programmable memory;

control processor means for accessing said library, comparing said voice command with the commands stored in said library and selecting a control sequence which is responsive to said voice command and which is adapted to actuate said selected operative function;

speech synthesizing means for generating a response signal from said control sequence which is confirmatory of the actuation of said selected operative function in response to said voice command;

at least one interface means adapted to convert:

said voice command into an electronic signal for reception and recognition by said speech recognition means;

an aspect of said control sequence into an electronic output signal capable of actuating said selected operative function;

said response signal into an audible speech signal;

means for transmitting said electronic output signal to said navigational guidance equipment; and

means for transmitting said audible speech signal to the originator of said voice command.

10. A system as claimed in claim 7, 8, or 9 wherein said navigational guidance equipment is air traffic control equipment.

11. A system as claimed in claim 7, 8, or 9 wherein said navigational guidance equipment is aerodrome facility equipment.

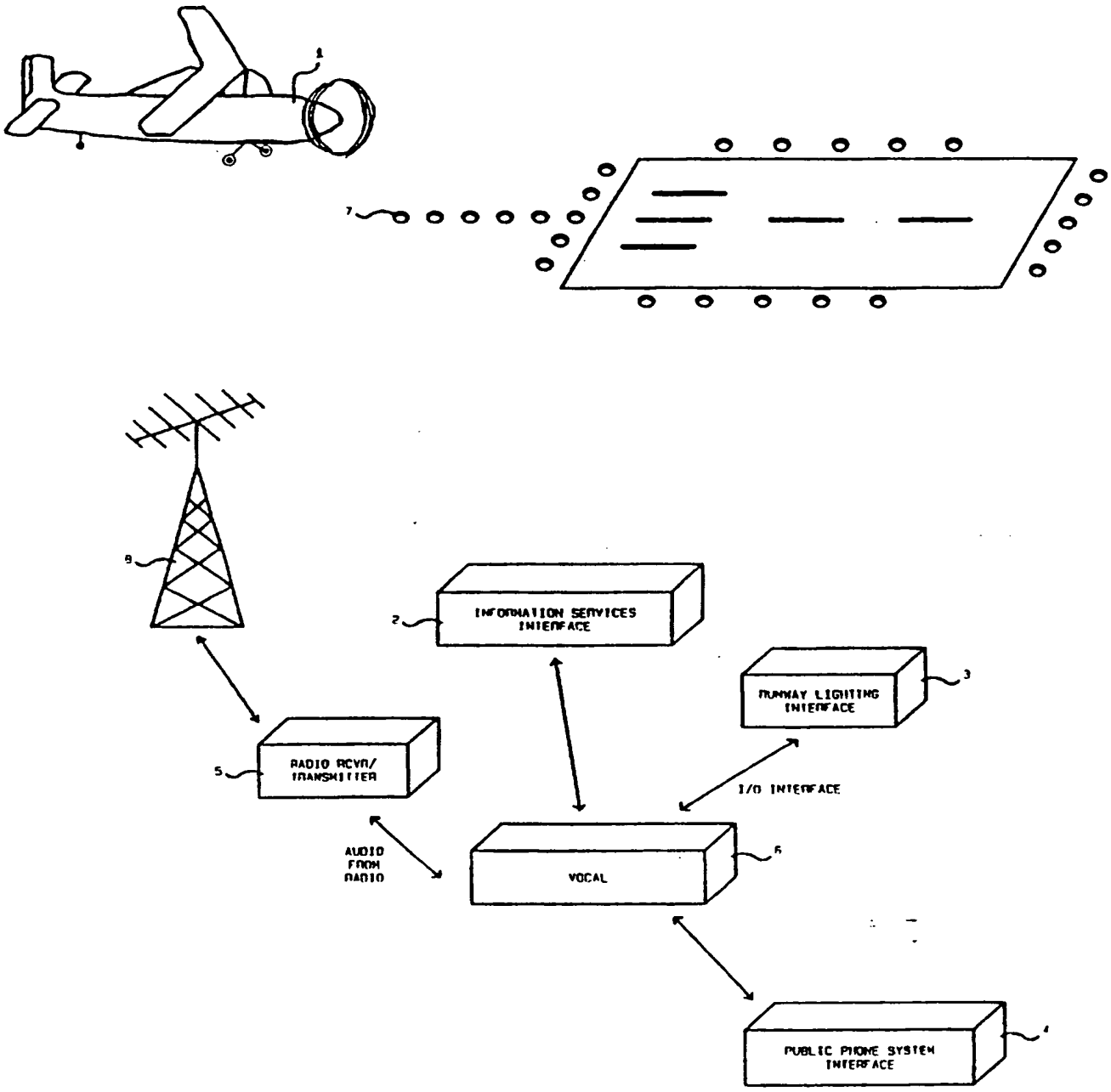
1
7
8
2
INFORMATION SERVICES INTERFACE
3
RUNWAY LIGHTING INTERFACE
5
RADIO RCVR/ TRANSMITTER
I/O INTERFACE
AUDIO FROM RADIO
6
VOCAL
4
PUBLIC PHONE SYSTEM INTERFACE

FIGURE 1

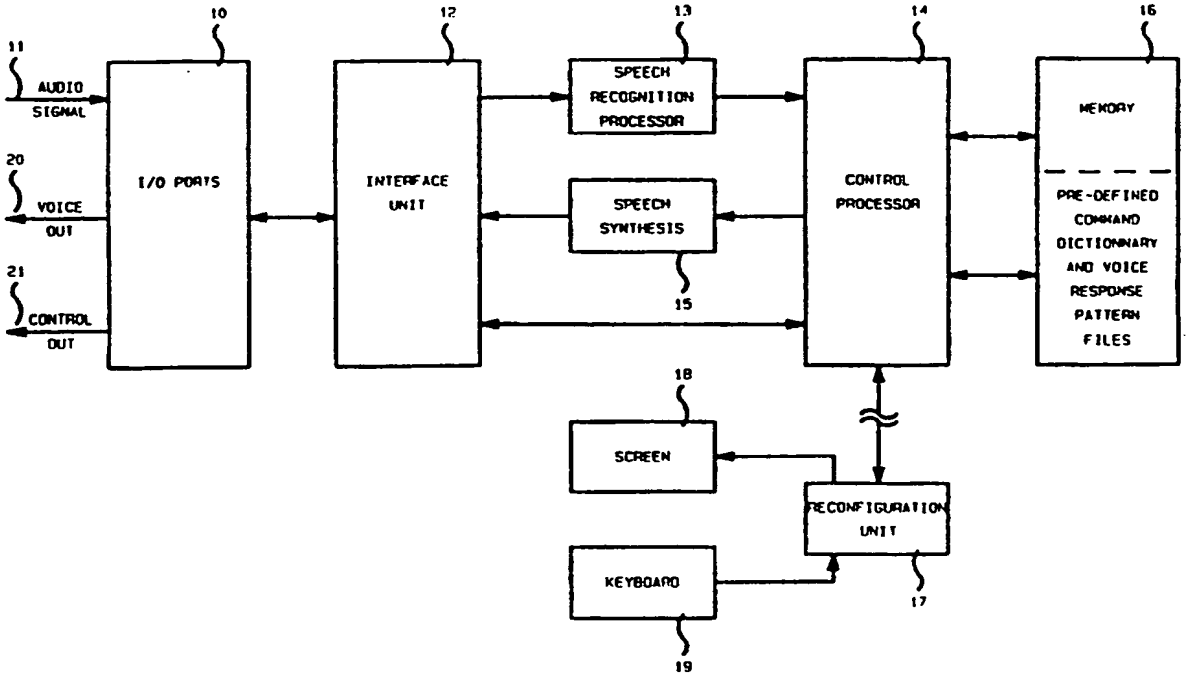
10
12
13
14
16
11
AUDIO SIGNAL
20
VOICE OUT
21
CONTROL OUT
I/O PORTS
INTERFACE UNIT
SPEECH RECOGNITION PROCESSOR
SPEECH SYNTHESIS
15
CONTROL PROCESSOR
MEMORY
PRE-DEFINED COMMAND DICTIONNARY AND VOICE RESPONSE PATTERN FILES
18
SCREEN
RECONFIGURATION UNIT
17
KEYBOARD
19

FIGURE 2

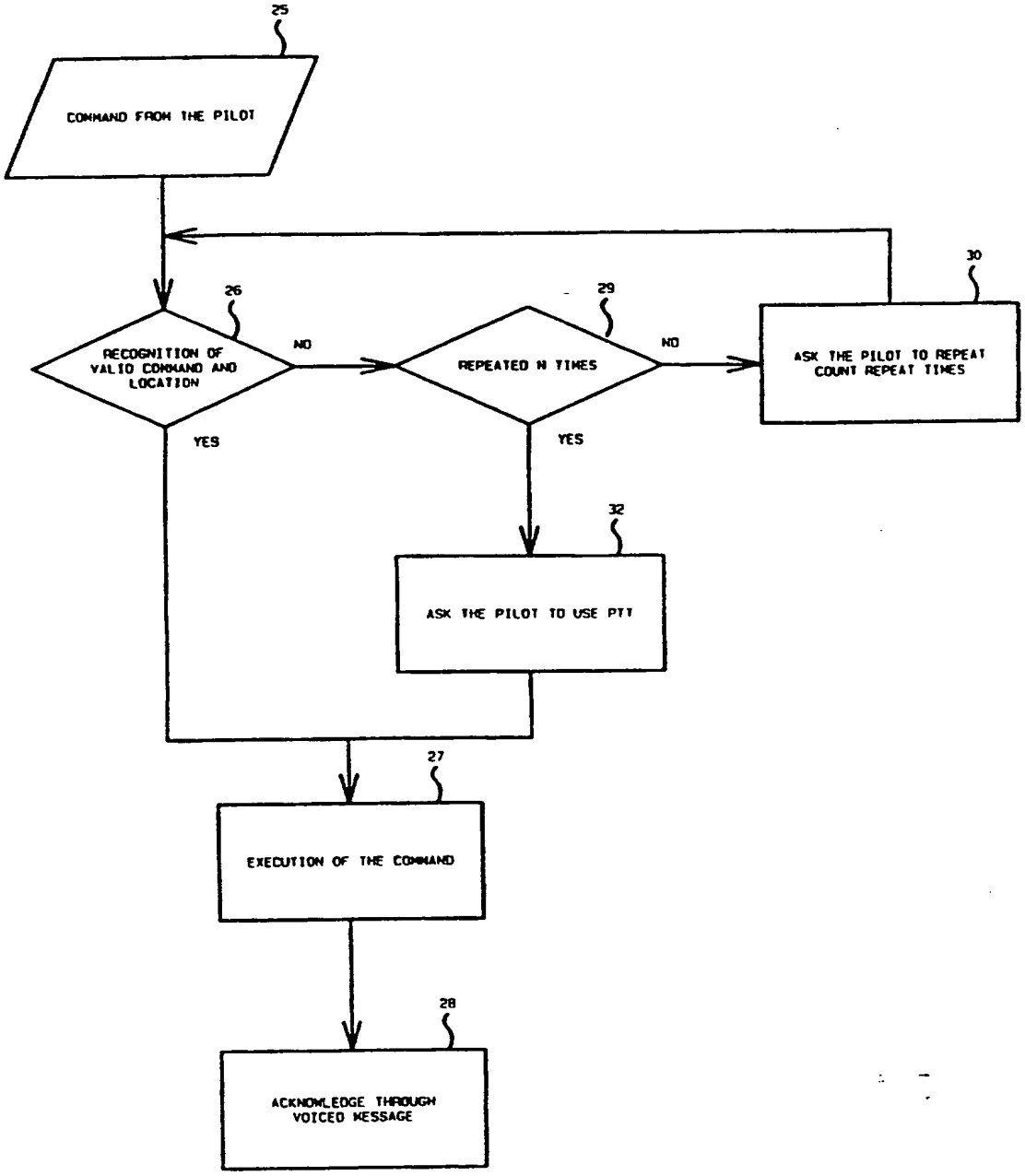
25
COMMAND FROM THE PILOT
26
RECOGNITION OF VALID COMMAND AND LOCATION
NO
29
REPEATED N TIMES
NO
30
ASK THE PILOT TO REPEAT COUNT REPEAT TIMES
YES
YES
32
ASK THE PILOT TO USE PTT
27
EXECUTION OF THE COMMAND
28
ACKNOWLEDGE THROUGH VOICED MESSAGE

FIGURE 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 97/00683

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G08G5/00 G10L3/00

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G08G G10L B64F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 725 956 A (JENKINS) 16 February 1988 see abstract ---	1,5,7,10
Y	EP 0 083 725 A (KEARNEY & TRECKER CORPORATION) 20 July 1983 see page 2, line 26 - page 5, column 15 ---	1-11
Y	FR 2 597 067 A (BRIATTE) 16 October 1987 see page 5, line 13 - page 27, line 30; figures ---	1-11
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 303 (P-1751), 9 June 1994 & JP 06 066591 A (RICOH CO LTD), 8 March 1994, see abstract --- -/--	1,7

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 December 1997	17/12/1997

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Reekmans, M

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 97/00683

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 365 171 A (GOYARD) 14 April 1978 see the whole document	1,5,6
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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ..ional Application No
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